PROJECT FACT SHEET

CONTRACT TITLE: Steel Casing Crosshole EM

ID NUMBER: FEW 0031

B&R CODE: AC1005000

CONTRACTOR: Lawrence Livermore National Laboratory

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PROJECT SITE
CITY: Livermore **STATE:** CA
CITY: Lost Hills Field **STATE:** CA
CITY: **STATE:**

CONTRACT PERFORMANCE PERIOD:
10/1/1993 to 4/15/2000

PROGRAM: Supporting Research
RESEARCH AREA: Rsvr Characterization
PRODUCT LINE: ADIS

FUNDING (1000'S)	DOE	CONTRACTOR	TOTAL
PRIOR FISCAL YRS	700	0	700
FISCAL YR 1999	250	0	250
FUTURE FUNDS	0	0	0
TOTAL EST'D FUNDS	950	0	950

OBJECTIVE: Develop and apply crosswell electromagnetic (EM) tomography to imaging reservoir properties through steel casing.

PROJECT DESCRIPTION:

Background: Oil field characterization is a very important activity in the production and exploitation of domestic oil resources. An integrated geologic simulator model is used to guide the placement of wells, and the engineering of recovery methods but, in general, is limited in accuracy by a lack of formation information between wells. Means are now at hand to extend the electrical resistivity distribution into the region between wells at sufficiently high resolution to map bypassed oil and steam swept zones from tertiary recovery processes. Interwell resistivity may be obtained using EM methods, which are an extension of the single hole EM methods used in borehole logging. The formation electrical resistivity is the parameter that is most influenced by the fluid content of rock. It has been therefore used for years in well log analysis to determine oil bearing zones intersected by wellbores and the oil saturation in these zones. This project attempts to extend crosswell EM methods that have been shown to work in fiberglass (non-metallic) cased boreholes to operate when the receiver is in a conventional steel cased borehole. Such an extension would be a crucial step in establishing the economic viability of routine EM crosswell monitoring methods for EOR operations.

Work to be Performed: The purpose of this research is to examine the potential of crosswell EM imaging for EOR monitoring when the receiver string is operated in a conventional steel cased borehole. Minimization of special non-metallic casing requirements will help to establish the economic viability of routine EM crosswell monitoring of EOR operations. The work consists of field operations designed to scope out the capabilities and limitations of crosswell EM monitoring through steel casing. Initial experiments will consist of repeat crosswell images in fiberglass casing with the receiver in and out of a steel sleeve that simulates the steel casing. This experiment will eventually be accomplished at a number of different frequencies. A later series of experiments will focus on before and after measurements in an open borehole and after emplacement of the steel casing. Results will be compared to theoretical work being conducted by another project.

PROJECT STATUS:

Current Work: FY2000 experiments will be closely tied both to a pilot and mature waterflood in a California diatomite heavy oil field. Crosswell EM will be conducted to provide time lapsed imaging of a waterflood migration using a single steel cased well and data will be acquired using dual steel cased boreholes holes at the same site for understanding detection mechanisms through cased steel. Efforts will also focus on the casing as a function of depth. The steel casing properties must be known to deconvolve the formation electrical properties from the convolved through-single-steel-casing data set consisting of attenuation and phase shifts due to both the formation and the steel casing. In the case of the dual steel cased boreholes, the solution and mathematical methodology and not yet determined, although fundamental research for this scenario will be conducted as well.

Scheduled Milestones:

Conduct multi-deployment crosswell EM tomography experiments using single and dual steel cased boreholes with in a waterflood as a function of time at Seneca Resources Lost Hills Field	03/00
Develop a forward modeling code which calculates the electromagnetic fields of a vertical dipole within a segmented steel casing and layered earth	07/00
Develop methodology to efficiently subtract the attenuation and phase shifts effects of through-single-steel cased boreholes	10/00
Conduct research into a viable solution of the dual steel cased borehole scenario using data, modeling results, and well logs	03/01

Accomplishments: The major accomplishments of this project from 98-99 have been: (1) Developed a calibration technique for Transmitter/Receiver; (2) Development of new data acquisition system; (3) Developed models which illuminate optimum frequency and spacing of the receiver within a steel cased borehole; (4) Deployment of fiber optic based system at Richmond Field Station; (5) Development of a method to subtract the attenuation and phase effects of one carbon steel cased b borehole; (6) Measurements between dual steel cased wells which indicate sufficient signal amplitudes; (7) Negotiated research contracts with Chevron and Seneca Resources; (8) Presentation of results to Society of Exploration Geophysicists.